IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Walter J. Smith	Confirmation No.:	7707
Serial No.:	10/805,084	Group Art Unit:	1733
Filed:	03/19/2004	Examiner:	Yao, Samchuan Cua
Title:	TURBINE BRUSH SEAL		

To: Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION OF WALTER J. SMITH UNDER 37 C.F.R. §1.131

I, Walter J. Smith, do hereby declare that:

1. I am Walter J. Smith, the named inventor in the above-noted matter, as well as being the named inventor of the parent application, U.S. Patent Application Serial No. 09/999,664.

2. About May 30, 2000, I received from my patent attorney, Wayne F. Reinke, a draft patent application and cover letter dated May 30, 2000 in the parent case.

3. On August 17, 2000, I met with Mr. Reinke at his office in Albany, New York, to discuss the draft application in the parent case.

4. Attached hereto as Exhibit A is a true copy of my hand written comments to the draft application, along with other of my notes and sketches. Among the notes is a page of graph paper referencing pages 13, 16 and 4 of the draft application, and including sketches of various cross-sectional shapes for the filaments of the invention. The sketches include a three-point star

shape, a four-point star shape, and a five-point star shape, each of which conforms to the definition of "n-point star" given in the present application at numbered paragraph 0039:

> "n-point star" shape refers to a shape that has at least three arms (i.e., $n \geq 3$), the faces of each arm extending from the body of the star and meeting either actually or extendedly in a sharp point, and where an angle between the faces of adjacent arms (either the actual angle if the faces meet at a point, or angle between the extensions of the faces if they meet at a radiused area) is less than 180 degrees from the perspective of outside the filament looking into the filament.

5. On February 5, 2004, I met with Mr. Reinke at his office to discuss the final Office Action in the parent case, dated October 22, 2004.

6. During the course of the February 5, 2004 conference, it was decided that the previous claim strategy in the parent case reciting included angles was not being interpreted as originally intended. Instead, it was decided to rephrase the claims for the filament to a cross-sectional shape of an n-point star, where "n" is three or more.

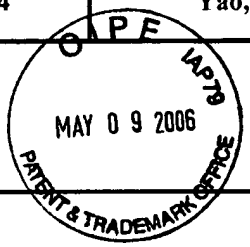
7. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Walter J. Smith

Date: May 4, 2006

CERTIFICATE OF MAILING BY FIRST CLASS MAIL (37 CFR 1.8) Applicant(s): **Walter J. Smith**			Docket No. **1370.002A**	
Application No. **10/805,084**	Filing Date **03/19/2004**	Examiner **Yao, Samchuan Cua**	Customer No. **23405**	Group Art Unit **1733**

Invention: **TURBINE BRUSH SEAL**



I hereby certify that this **Declaration of Walter J. Smith Under 37 C.F.R. Section 1.131**
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is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)] on **May 5, 2006**
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May 30, 2000

Mr. Walter J. Smith
88 Chester Street
Ballston Spa, New York 12020

Re: U.S. Patent Application
Title: BRUSH SEAL AND METHOD AND SYSTEM FOR INSTALLING SAME
Our File No.: 1370.002

Dear Mr. Smith:

Enclosed is a copy of a draft patent application and informal drawings prepared on the subject invention. Please carefully review this application for accuracy and completeness. Any necessary additional information, comments, suggestions, questions or the like should be marked right on the copy. In that regard, please note the questions in bold throughout the application.

Rule 1.56 of the U.S. Patent Office Rules of Practice states that a duty of candor and good faith towards the Office rests with the inventor. This includes a duty to disclose to the Patent Office information which the inventors are aware of which is material to the examination of the patent application. Failure to disclose material information known by the applicants can result in invalidation of some or all of the claims. Information is considered material when it is not cumulative to information already of record and the information:

(1) establishes, by itself or in combination with other information, a case which, on the face of it, would render any claim unpatentable; or

(2) it refutes, or is inconsistent with, positions taken by us in arguing for patentability.

In order to fulfill this duty, it is important that you advise us of the following:

(a) Relevant prior art, i.e., patents, printed publications or other information relating to similar work done in the past by others.

(b) Information relating to any public use, sale, offer for sale (e.g., proposal) or printed description of your invention.

(c) Any other information you feel might be considered "material."

To assist you in this effort, enclosed is a list of references of which we are already aware. After carefully reviewing the enclosed list and patent application, please indicate below any additional information of which you are aware that might be material to the examination by the Patent Office of said application. If there is no additional information, please so indicate.

Also, kindly indicate or confirm the existence of any U.S. Government sponsorship of this invention, in the space provided below. If you have any question as to what constitutes U.S. Government sponsorship, please call us.

After your review, please contact me with your comments.

Very truly yours,

HESLIN & ROTHENBERG, P.C.

Wayne F. Reinke

Wayne F. Reinke
Email: wfr@hriplaw.com

WFR:rqs
Enclosures
N:\USERS\STAFF\RQS\2000\1370002.156

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-or-

_____ THE BELOW-IDENTIFIED INFORMATION MAY BE MATERIAL TO THE EXAMINATION OF THE APPLICATION BY THE PATENT OFFICE:

U.S. Government Sponsorship of invention:

____ NO ____ YES: Agency: _____

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Date Inventor Signature

TO VERIFY THE ACCURACY OF OUR RECORDS, WOULD YOU KINDLY COMPLETE THE FOLLOWING (PLEASE PRINT):

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First Name Middle Last

_____

Residence Address: Street City County State Zip Country

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Post Office Address–if different from residence

Citizenship: _____ U.S.A. ____ Other: _____

Page 13 - claim #19 "filiment has a non-circular cross-sectional shape . . . and

Page 16 - claim #37

Page 4 - fig 9 -

any shape that has corners, included angles, flat surfaces or concave surfaces will have a higher flow resistance coefficient than a round shape.

the corners of these shapes will need to be radiused slightly to reduce abrasion with adjacent bristles

METHOD, APPARATUS AND SYSTEM FOR CREATING A BRUSH SEAL

BACKGROUND OF THE INVENTION

Technical Field

The present invention generally relates to brush seals. More particularly, the present invention relates to the creation of brush seals using electrostatic flocking.

Background Information

In the past, large rotating element machines, such as, for example, turbines, incorporated labyrinth seals to reduce losses between high and low pressure areas, resulting in efficiency losses for the machine. As one skilled in the art will know, labyrinth seals comprise spaced hard "teeth" projecting out from, e.g., a stationary or rotating element, and almost touching the corresponding rotating or stationary member when at rest. At start up, the teeth would often contact the corresponding member, due to thermal expansion and contraction leading to radial and axial growth disparities between stationary and rotating members, causing damage to that member and/or the teeth. Further damage is possible, due to vibration when critical speeds are reached. This damage would lead to ~~pressure losses~~ leakage rate increases, and, hence, efficiency losses. This problem was addressed by providing additional space between the teeth and the corresponding member. However, this too reduced efficiency, since it left a slight gap between the teeth and corresponding member during operation.

Pressures are fixed by flow path geometry and don't change appreciably, but secondary leakage flows increase

Further improvements to the basic labyrinth structure included the addition of a "honeycomb" erodible element on the member opposite the teeth. This allowed the teeth to wear away the honeycomb element without physical damage to the corresponding member during startup. Although the resulting gap was smaller than prior to the inclusion of the honeycomb element, there was still an unacceptable efficiency loss. This led to brushes with flexible filaments that would bend during start up. These flexible filaments produced the smallest gap yet during normal operation.

Presently, the flexible filaments are cut longer than ultimately needed, taking into account ~~eventual partial wearing away~~. In addition, the filaments are manually stacked in some fashion. Typically, the filaments are welded between two metal rings, referred to as "sealing rings." However, up to two thirds of the space needed for the brush seal can be used by the rings. The space needed for the sealing rings is, thus, a limiting factor to the available seal "length" (an industry term referring to the width of the filaments between the sealing rings). The process of compressing the sealing rings and the filaments together for welding and cutting the filaments to length is also labor intensive.

Thus, a need exists for a way to increase the available seal length and, therefore, increase efficiency.

SUMMARY OF THE INVENTION

Briefly, the present invention satisfies the need for a way to increase the available seal length in a brush seal by replacing the sealing-ring arrangement with a bonding agent and

flexible filaments electrostatically flocked into the bonding agent. This allows for a much larger seal width, and improved efficiency, at a lower cost.

In accordance with the above, it is an object of the present invention to provide a brush seal with a larger seal width than currently available.

The present invention provides, in a first aspect, a method of creating a brush seal. The method comprises applying a bonding agent to a member, either stationary or rotating, and electrostatically flocking a plurality of flexible filaments into the bonding agent to create the brush seal.

The present invention also provides apparatus and system aspects implementing the method of the present invention.

These, and other objects, features and advantages of this invention will become apparent from the following detailed description of the various aspects of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts a bonding agent being applied within a groove of a member.

FIG. 2 depicts the member of FIG. 1 with flexible filaments electrostatically flocked into the bonding agent.

FIG. 3 depicts the member of FIG. 2 with the flexible filaments being angled.

FIGs. 4-8 depict alternate embodiments of brush seals in accordance with the present invention.

Fig 9- depicts optional cross sectional shapes of the individual brush bristle

BEST MODE FOR CARRYING OUT THE INVENTION

A method of creating a brush seal will now be described with reference to an example depicted in FIGs. 1-3. FIG. 1 depicts a cylindrical member 100 with a groove 102 machined therein. Cylindrical member 100 is, for example, a ~~stator~~ rotating shaft of, for example, a turbine. Groove 102 is, for example, 0.2" deep [~~HOW DEEP?~~], and is machined using, for example, A LATHE [WHAT?]. A bonding agent 104 is evenly applied to the grooved area via spray applicator 106, while cylindrical member 100 is slowly rotated such that the bonding agent remains evenly distributed and does not drip off. Spray applicator 106 is, for example, an automated spray applicator, similar to that used for conformal coating of electronic components [~~TRUE?~~]. Bonding agent 104 is, for example, a molten ceramic or ~~braise~~ Molten Metal material, such as, for example, [NEED EXAMPLE]. As one skilled in the art will know, a ~~braise~~ material is [NEED DESCRIPTION], and is useful, for example, when an area of the groove is sought to be left without any brush seal filaments. **[PLEASE CONFIRM HOW AREAS ARE LEFT OPEN – SEE CLAIM 9.]**

In the present example, bonding agent 104 is evenly distributed over the surface of groove 102. ~~However, it will be understood that the bonding agent could be unevenly distributed [TRUE?], for example, if one or more areas of the groove are sought to be left without the bonding agent~~. In addition, it will be understood that the groove is not necessary

for the basic invention. The bonding agent can be applied to any surface of a member. It will also be understood that spray applicator 106 could be manually controlled, or instead be a brush or other type of applicator. Further, cylindrical member 100 need not be rotated during bonding agent application; instead, the applicator could be manipulated (e.g., rotated) about the groove.

FIG. 2 depicts the cylindrical member 100 of FIG. 1 after the application of bonding agent 104 to groove 102. As shown, a plurality of flexible filaments 200 are being electrostatically flocked into the bonding agent via flocking apparatus 202. The filaments are flexible so that during start-up, there is some "give" in the face of thermal expansion and contraction. The flocking is done while cylindrical member 100 is slowly rotated, or, alternatively, while cylindrical member 100 remains in place and flocking apparatus 202 is manipulated about the groove. Flocking apparatus 202 comprises, for example, flocking gun 204, compressor 206, and hopper 208 to hold flexible filaments 200. The flexible filaments could be precut or cut to size after application. The compressor at one end 210 of gun 204 allows the filaments to be drawn out of hopper 208 and "shot" into bonding agent 104 at the other end 212. The flocking process can be automated or manual. In this manner, a brush seal is created with a longer seal ~~length~~ for a given geometry, and expressly without the need for sealing rings to stack to filaments and weld to the member. With a longer seal length, the filaments can also be smaller in cross-section, which reduces friction and improves flexibility. ~~This should translate into much less damage and less maintenance~~.

~~Although~~ compressor 206 ~~might assist to some small extent in~~ propelling filaments 200 into bonding agent 104, ~~it's a potential difference that does so~~. Flocking gun 204 is kept at a positive direct current (DC) potential [ROW?], while cylindrical member 100 is kept at

 melton adhesive remelt point must be above the running temp of the machine

a negative DC potential [HQW?], which causes filaments 200 exiting gun 204 at end 212 to be attracted to the ~~negative~~ opposite polarity potential. Further, the potential difference will also cause the filaments to align perpendicular to the surface into which they are shot, or, in this case, perpendicular to the normal of the surface where curved. The potential difference is, for example, about 15,000 volts DC.

Flexible filaments 200 are made of, for example, metal (e.g., [NEED EXAMPLE]) and preferably cut to length or slightly longer to allow for some degree of wearing from friction. However, where the filaments are made of metal or any other material that can hold a charge, they will begin to stick together upon exiting the flocking gun (or before) if left alone. Thus, the conducting filaments are preferably coated with an electrical insulator, such as, for example, an oxide, so long as the melting point of the insulator is higher than that of the bonding agent for hot applications. The insulator could be applied in a number of ways. For example, the metal filaments could be placed in a fluidized bed of the insulator material and removed, so as to fully coat them, or applied to the stock before it is cut to length [ANY OTHER WAYS TO DO IT?]. The addition of the electrical insulator does, of course, change the stiffness of the filaments, which would need to be considered when the filaments are being designed for the particular purpose.

Haynes 25 (cobalt alloy) or ceramic Haynes fiberglass, Carbon fiber, & Ceramics

and preferably cut to length and consistent size

In cold applications, i.e., where the bonding agent is not hot during electrostatic flocking, the flexible filaments are preferably non-conductive. For example, the filaments could comprise glass, polyimide, nylon or rayon. In such applications, bonding agents such as, for example, epoxies and rubber adhesives could be used. a conductive powder may want to be added if the bonding agent is of high electrical resistance

$10^8 \Omega$ resistance

As noted above, the electrostatic flocking process results in the flexible filaments being aligned perpendicular to the surface coated with the bonding agent. For some

applications, it may be desired that the flexible filaments be angled, rather than perpendicular, to the surface or normal of the member. FIG. 3 depicts cylindrical element 100 after flexible filaments 200 have been electrostatically flocked into bonding agent 104 before it hardens. Angle adjustment tool 300 is brought into contact with flexible filaments 200, and is simply a surface with which filaments 200 come into contact during rotation with respect to cylindrical element 100 such that the angle thereof changes to a desired angle. In the present example, angle adjustment tool is simply a shaft with a smooth face that is brought into contact with the flexible filaments prior to hardening of the bonding agent. For example, although opinions differ on the issue, filament angles for turbines are currently thought to be nominally best at about 45 degrees with respect to the normal of the surface. Alternatively, angle adjustment tool 300 could have, for example, a grooved face such that not all of the filaments become angled, or so that some are angled to a lesser or greater extent than others. **[IS THAT THE PURPOSE FOR GROOVED FACE?]**

FIGs. 4 through 8 present examples of alternative embodiments for the brush seal of the present invention. FIG. 4 depicts a retrofitted labyrinth seal 400, comprising a first member 402 and a second member 404. One of members 402 and 404 rotates relative to the other. In the example of FIG. 4, labyrinth teeth 406, 408 and 410 extend out of member 402 toward member 404. The labyrinth teeth are inflexible metal. Member 404 comprises a groove 412 in which flexible filaments 414 have been electrostatically flocked into a bonding agent 416 applied thereto. The filaments coinciding with the locations of the labyrinth teeth have been sized appropriately. In this manner, a labyrinth seal can be retrofitted to include the brush seal of the present invention, while not removing the labyrinth teeth.

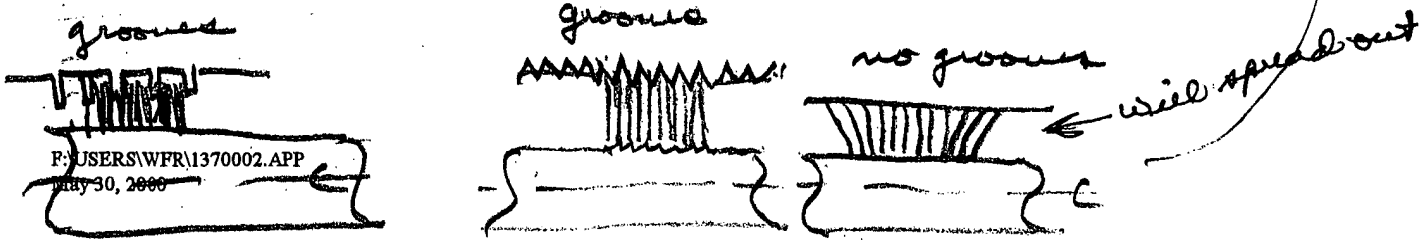


FIG. 5 depicts another embodiment of a retrofitted labyrinth brush seal 500. Like seal 400, seal 500 has a member 502 with labyrinth teeth 504, 506 and 508 extending therefrom toward another member 510. One of members 502 and 510 rotates relative to the other. Member 502 also includes groove 512 in which flexible filaments 514 have been electrostatically flocked into a bonding agent 516 within groove 512. Thus, seal 500 is similar to seal 400, except that the flexible filaments are retrofitted onto the same member as incorporates the labyrinth teeth. In addition, the labyrinth teeth of seal 500 act as backers for the flexible filaments to prevent them from bending over due to a pressure drop.

I would put this ahead of the previous idea. It is a better design as it allows for axial movement at the bristle

FIG. 6 depicts another embodiment of a brush seal 600 in accordance with the present invention. The brush seal is made between members 602 and 604, one of which rotates with respect to the other. Member 604 comprises groove 606 having various groove depths thereacross. Flexible filaments 608 have been electrostatically flocked into a bonding agent 610 within groove 606. The varying depths of groove 606 allow flexible filaments of the same length to extend different distances between members 602 and 604. It may be desired in some applications not to have all of the flexible filaments extending the same distance toward the corresponding member, for example, to reduce friction at start up. An alternative to FIG. 6 that also produces the different filament distances is actually cutting the filaments to the various desired lengths after the bonding agent hardens. (Also provides a brush seal that incorporates the characteristics of a hi-lo labyrinth seal)

FIG. 7 depicts still another embodiment of a brush seal 700 in accordance with the present invention. Brush seal 700 is made between members 702 and 704, with member 704 including multiple independent grooves 706, 708 and 710. Each groove comprises flexible filaments, such as flexible filaments 712 in groove 706, that have been electrostatically flocked into a bonding agent applied within the groove, e.g., bonding agent 714 in groove

706. The design of brush seal 700 allows for flexible filaments of all the same length with spaces in between groups of filaments.

FIG. 8 depicts yet another example of a brush seal 800 between members 802 and 804. Member 804 includes a separate member 806 (in this case, a ring) placed within a groove 807 of member 804. Member 806 includes flexible filaments 808 electrostatically flocked into a bonding agent 810. Since member 806 is separate from member 804, it allows the electrostatic flocking to be done prior to the coupling of member 806 and member 804. In some cases, however, member 806 may need to be attached to member 804 in two or more segments, for example, if it is a ring being put on the inside diameter of a turbine member. In addition, if the flexible filaments will be angled, it may also be advisable to angle the ring cut to correspond with the angle of the filaments, preventing a gap therein. In one scenario, member 806 comprises metal, as does member 804, and member 806 is welded into member 804.

P—— brush seal applied to surface of one member (No groove)

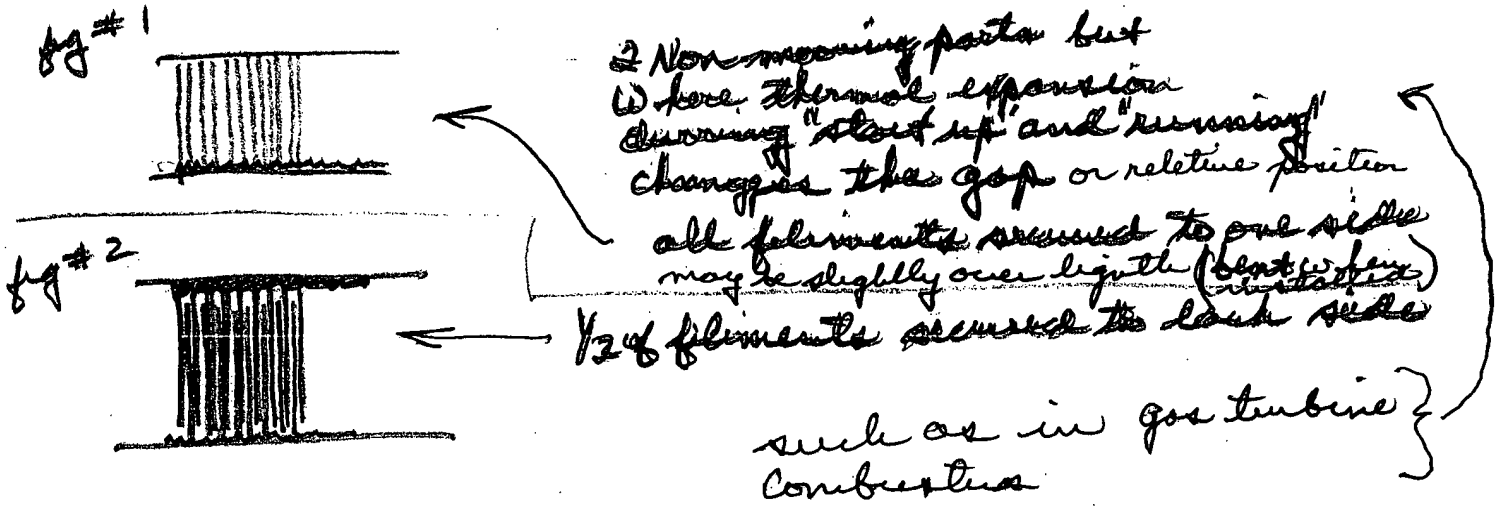
The efficiency of a brush seal is affected by the cross-sectional shape of the individual filaments. In general, any cross-sectional shape with angles (i.e., non-circular) is better for reducing air or fluid flow than a circular cross-section, which produces more eddys around the filaments. However, sharp angles may also cause abrasion with adjacent filaments. Thus, the angles of the non-circular cross-section are also preferably rounded or blunted, which may actually happen naturally during the process of making the filaments. For example, where the filaments are extruded and stretched, any corners may be rounded during the process. Examples of non-circular cross-sectional flexible filament shapes include various multi-point stars, and squares. shapes with included angles or convex sides would be best

actually sharp edges produce more eddys, & you want to make flow as turbulent as possible to minimize flow.

random orientation of individual filaments relative to each other

Need to add Figure 5

While several aspects of the present invention have been described and depicted herein, alternative aspects may be effected by those skilled in the art to accomplish the same objectives. For example, to serve a similar purpose as the labyrinth teeth of FIG. 5, one could add one or more backer rings to the brush seal of the present invention. Although a backer would reduce somewhat the achievable seal length for a given geometry, in some applications it may be desirable to prevent over-bending of the filaments from excessive pressure drops, for example. In addition, the invention is applicable anywhere there are members moving relative to each other and a majority (not necessarily all) of a gas or liquid flow is sought to be stopped. Accordingly, it is intended by the appended claims to cover all such alternative aspects as fall within the true spirit and scope of the invention.



Add claims about addition of anti-capillary action treatment to bristles

CLAIMS

1. A method of creating a brush seal, comprising:

applying a bonding agent to a member; and

electrostatically flocking a plurality of flexible filaments into the bonding agent to create the brush seal.

2. The method of claim 1, further comprising creating a groove in the member, and wherein the applying comprises applying the bonding agent within the groove.

3. The method of claim 2, wherein creating the groove comprises creating the groove with at least two different depths.

4. The method of claim 1, wherein the brush seal is installed in a machine between a rotating member and a stationary member, and wherein the member is the rotating member.

5. The method of claim 1, wherein the brush seal is installed in a machine between a rotating member and a stationary member, and wherein the member is the stationary member.

Both are stationary

6. The method of claim 1, wherein applying the bonding agent comprises applying a molten material to the member.

Good catch!

7. The method of claim 6, wherein applying the molten material comprises applying a molten ceramic material. with appropriate electrical conductivity

8. The method of claim 6, wherein applying the molten material comprises applying a molten ~~braise [IS "BRAISE" THE RIGHT WORD?]~~ material. Metal with appropriate electrical conductivity

9. The method of claim 8, further comprising, prior to applying the molten ~~braise~~ material, applying a material in at least one area of the groove where an absence of the plurality of filaments is desired to prevent the molten ~~braise~~ BONDING material from bonding to the member in the at least one area. stop off

10. The method of claim 1, wherein the plurality of flexible filaments comprise at least one ~~electrically conductive~~ with the appropriate electrical conductivity flexible filament, the method further comprising coating the at least one ~~electrically conductive~~ material to achieve the appropriate electrical conductivity flexible filament with a ~~[illegible]~~ or prior to the electrostatically flocking.

same as 10 but reverts situation (add conductive coating to resistive filament)

11. The method of claim 1, wherein applying the bonding agent comprises applying an epoxy to the member. with an appropriate electrical conductivity

12. The method of claim 1, wherein applying the bonding agent comprises applying an adhesive to the member. with an appropriate electrical conductivity

13. The method of claim 1, wherein applying the bonding agent comprises rotating the member.

14. The method of claim 1, wherein the plurality of flexible filaments comprise at least one ~~electrically insulating~~ flexible filament. with an appropriate electrical resistivity

15. The method of claim 1, further comprising repositioning at least some of the plurality of flexible filaments before the bonding agent solidifies.

16. The method of claim 15, wherein repositioning comprises angling the at least some of the plurality of flexible filaments with respect to a normal out of a surface of the member.

17. The method of claim 1, wherein the brush seal is installed on a machine, the method further comprising coupling the member to the machine.

18. The method of claim 17, further comprising creating a groove in the machine, and wherein the coupling comprises placing the member in the groove.

19. The method of claim 1, wherein at least one of the plurality of flexible filaments has a non-circular cross-sectional shape.

20. The method of claim 1, further comprising angling at least some of the plurality of flexible filaments.

21. A brush seal, comprising:

a member;

a bonding agent on a surface of the member;

a plurality of flexible filaments embedded in the bonding agent; and

wherein there is an absence of sealing rings coupling the plurality of flexible filaments to the member.

I'm not quite sure what this means (WAT)

22. The brush seal of claim 21, wherein the member is part of the machine.

23. The brush seal of claim 22, wherein the member comprises a groove, and wherein the bonding agent resides in the groove.

24. The brush seal of claim 23, wherein the groove has at least two different depths.

25. The brush seal of claim 22, wherein the member comprises one of a rotating part and a stationary part.

26. The brush seal of claim 21, wherein the brush seal is for coupling to a machine, and wherein the member is separate from the machine.

27. The seal of claim 26, wherein the machine comprises a groove sized to fit the member therein.

28. The brush seal of claim 21, wherein the bonding agent comprises a material with a lower melting point than the plurality of flexible filaments.

29. The brush seal of claim 28, wherein the bonding agent comprises a ceramic material.

30. The brush seal of claim 28, wherein the bonding agent comprises a ~~braise~~ Molten metal material.

31. The brush seal of claim 21, wherein the brush seal comprises at least one area having an absence of the plurality of flexible filaments.

32. The brush seal of claim 21, wherein the plurality of flexible filaments comprise at least one electrically conductive flexible filament coated with an electrical insulator. of a given Value

33. The brush seal of claim 21, wherein the plurality of flexible filaments comprise at least one electrically insulative flexible filament of a given value

34. The brush seal of claim 21, wherein the bonding agent comprises an epoxy.

35. The brush seal of claim 21, wherein the bonding agent comprises an adhesive.

36. The brush seal of claim 21, wherein at least one of the plurality of flexible filaments is angled with respect to a normal out of the member.

37. The brush seal of claim 21, wherein at least one of the plurality of flexible filaments has a non-circular cross-sectional shape.

38. The brush seal of claim 21, wherein at least some of the plurality of flexible filaments are angled.

39. The brush seal of claim 21, wherein at least one backer on the member for at least some of the plurality of flexible filaments.

40. A system for creating a brush seal, comprising:

a bonding agent for applying to a member;

a plurality of flexible filaments; and

an electrostatic flocking machine for embedding the plurality of flexible filaments into the bonding agent to create the brush seal.

41. The system of claim 40, further comprising a **[WHAT?]** for creating a groove in a member on which the bonding agent is to be applied.

42. The system of claim 40, wherein the bonding agent comprises a ceramic material.

43. The system of claim 42, wherein the bonding agent comprises a ~~braise~~ material.

44. The system of claim 40, wherein the bonding agent comprises an epoxy.

45. The system of claim 40, wherein the bonding agent comprises an adhesive.

46. The system of claim 40, further comprising a material for applying in at least one area of a member on which the bonding agent is to be applied where an absence of the plurality of flexible filaments is desired to prevent the bonding agent from bonding to the member in the at least one area.

47. The system of claim 40, wherein the plurality of flexible filaments comprises at least one electrically conductive flexible filament coated with an electrical insulator.

48. The system of claim 40, wherein the plurality of flexible filaments comprises at least one electrically insulating flexible filament.

49. The system of claim 40, wherein the plurality of flexible filaments comprises at least one flexible filament having a non-circular cross-sectional shape.

50. The system of claim 40, further comprising a [WHAT?] for angling the plurality of flexible filaments after embedding within the bonding agent and before the applied bonding agent solidifies.

51. The system of claim 40, wherein the electrostatic flocking machine comprises:

a flocking gun;

a compressor;

a hopper for holding the plurality of flexible filaments; and

means for producing a potential difference between the flocking gun and the member.

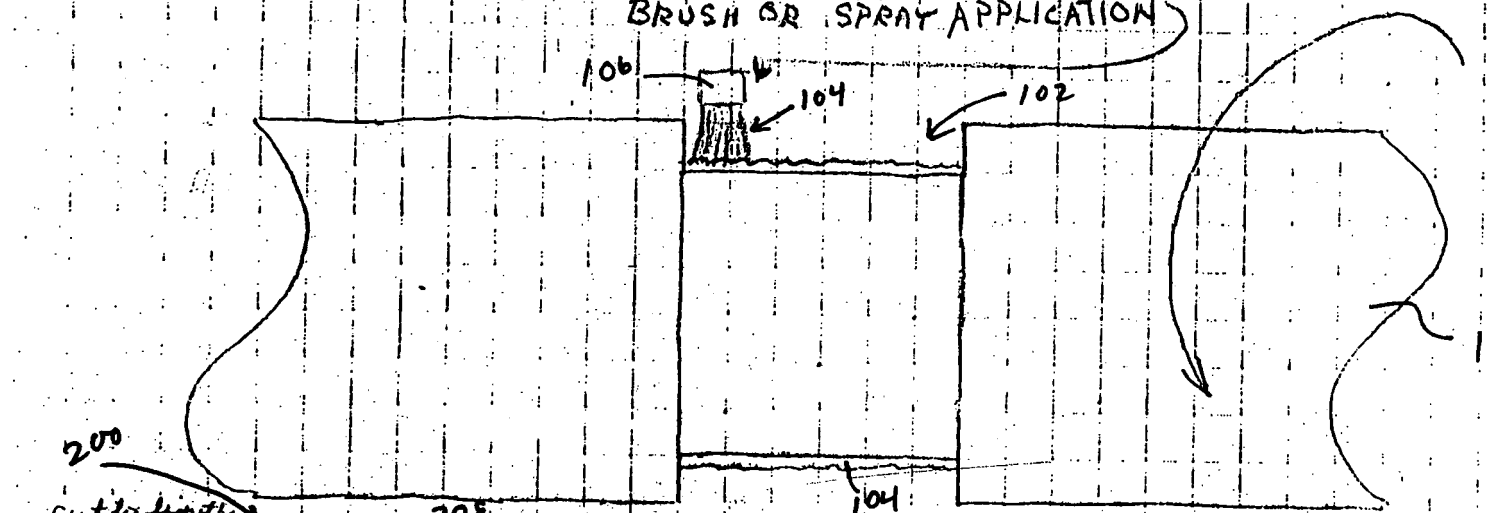
METHOD, APPARATUS AND SYSTEM FOR CREATING A BRUSH SEAL

ABSTRACT OF THE DISCLOSURE

A brush seal is created between two members, one rotating with respect to the other. In one member, a groove is created in which a bonding agent is applied. Flexible filaments are then electrostatically flocked into the bonding agent. After the bonding agent hardens or cures, the brush seal is created.

(M)

BONDING AGENT APPLICATION
BRUSH OR SPRAY APPLICATION



ROTATE PART SLOWLY (CYLINDRICAL PARTS) FOR UNIFORM DISTRIBUTION

FIG. 1

FLOCKING PROCESS (ELECTROSTATIC)

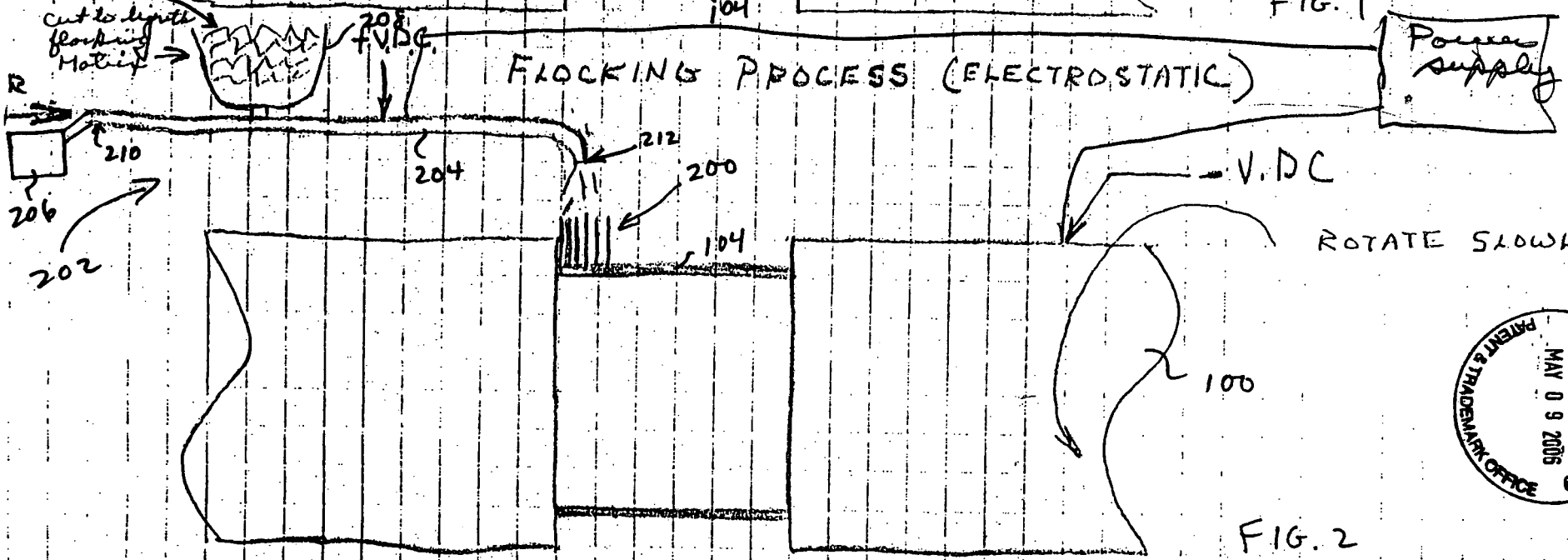
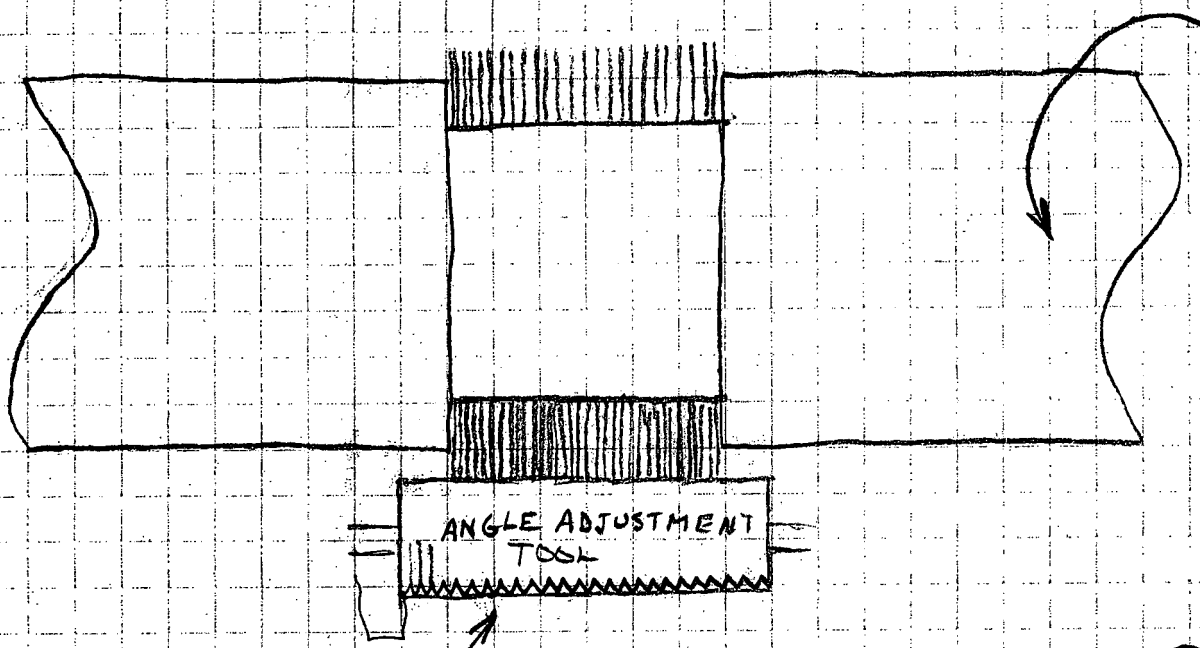


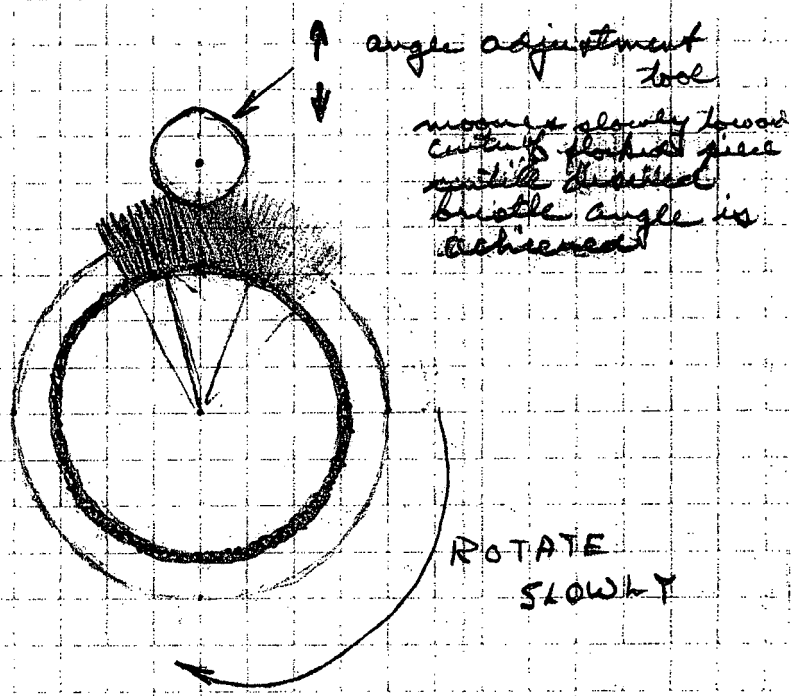
FIG. 2

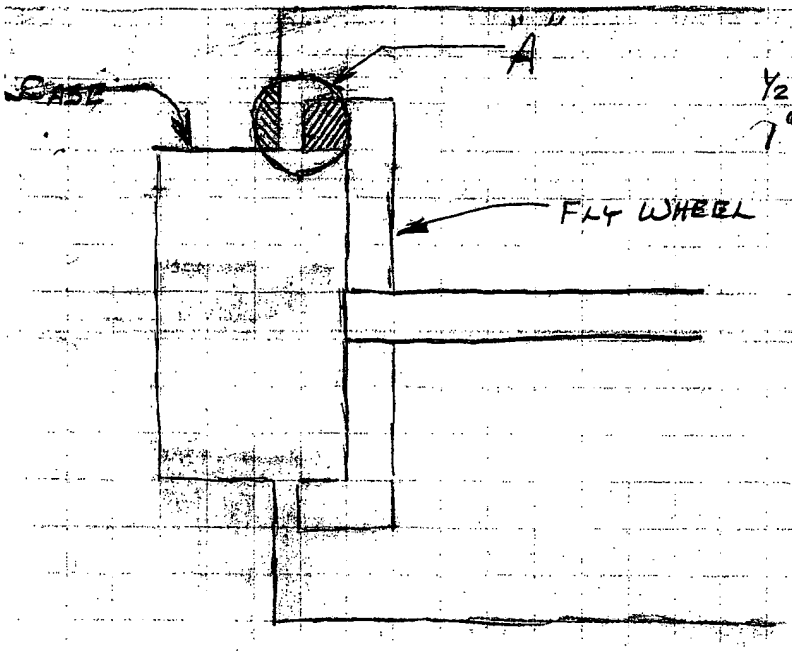
Controls rotation speed, air pressure, and flocking magnet movement to achieve density desired

FIG 3

BRISTLE ANGLE ADJUSTMENT



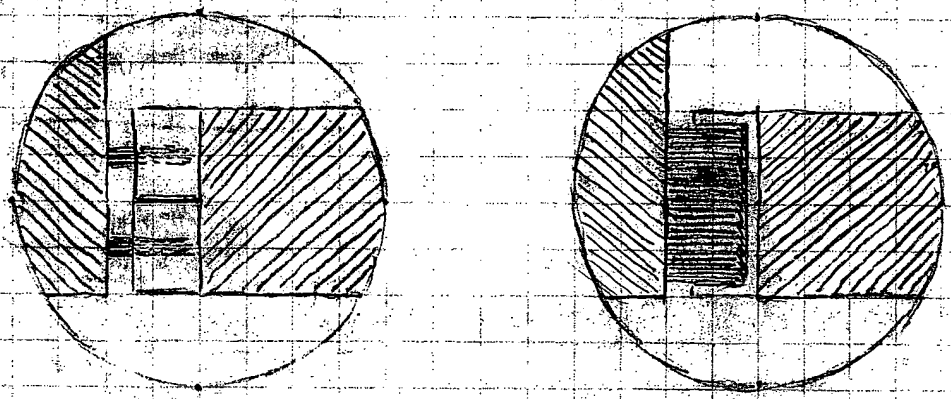




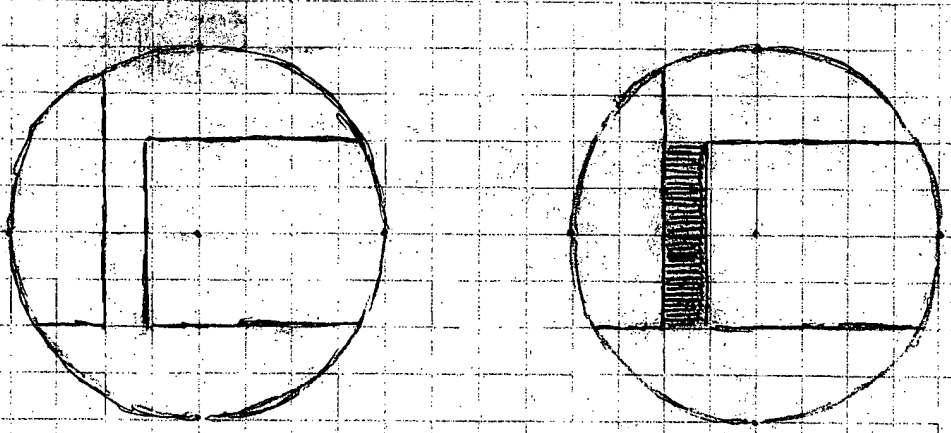
½" AXIAL CLEARENCE
7" RADIAL SEAL LEGNTH

STANDARD BRUSH

ELECTROSTATICLY APPLIED BRUSH



½" AXIAL CLEARENCE
1" RADIAL SEAL LEGNTH



.2" AXIAL CLEARENCE
1" RADIAL SEAL LEGNTH

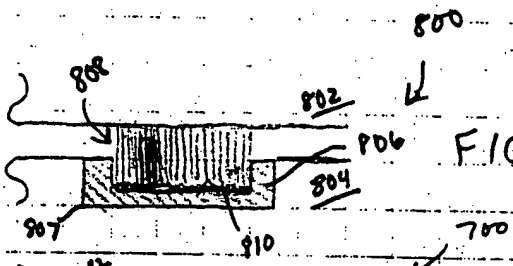


FIG. 8

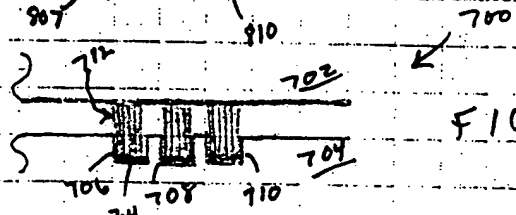


FIG. 7

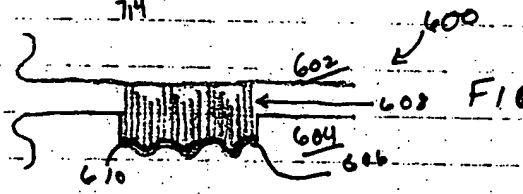


FIG. 6

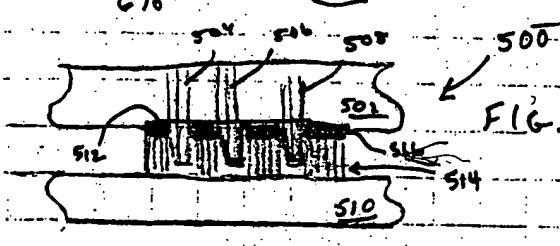


FIG. 5

make fresh example

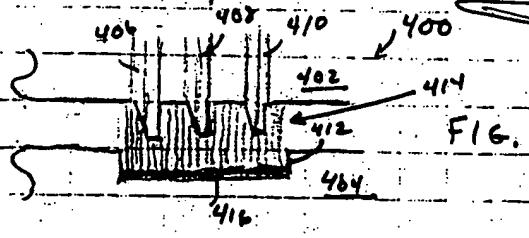


FIG. 4